Managerial Flexibility in Turbulent Times of Crisis

João Carlos Monteiro[1], José António Filipe[2]

[1] *Instituto Superior Politécnico Gaya (ISPGaya), Portugal*
jmonteiro@ispgaya.pt

[2]*Instituto Universitário de Lisboa (ISCTE-IUL), BRU – IUL, Portugal*
jose.filipe@iscte.pt

Abstract - **The recent change in the global economic environment produced a significant transformation in the conditions that affect managerial decisions. In fact, the increase in globalization led to higher managerial flexibility and a transformation in competition. Additionally, the financial crisis caused a lack of liquidity in financial markets. These circumstances originated a shift in the way investment opportunities should be analysed in global industries. Managerial flexibility can translate itself into expansion to other markets besides the initial ones. This possibility is analysed in the existing literature through real options analysis. In global markets competition is assured by global firms. However, the number of these firms is scarce. Therefore, global competition is made by a limited number of firms. This type of competition is analysed in the existing literature through game theory. The lack of liquidity in financial markets makes financing harder to obtain and exacerbates the conflicts of interests between the different stakeholders of a firm. Such conflicts are studied in the existing literature through agency theory. Therefore, a real options analysis under agency conflicts between equity and debt in the presence of competition is well suited to analyse investment opportunities in the present economic environment. The setting under which such analysis is performed considers two firms in a market that share a growth option to expand its scale of operations for a fixed investment outlay. The firms are financed by both equity and debt and the exercise of the expansion option is financed by an additional equity issue. Cournot-Nash equilibrium is considered and two alternative managerial policies are set: a first-best policy, which maximizes the value of the firm and a second-best policy, which maximizes the value of the equity of the firm. The results obtained with the numerical simulation performed demonstrate that agency costs exist in the presence of competition and lead to an underinvestment situation.**

Keywords - *Real Options, Agency Theory, Game Theory and Capital Structure.*

1. Introduction

The economic environment in which firms operate is in constant transformation. The growing globalization of the market economy affects managerial decisions and changes the paradigms under which such decisions are based on. In fact, globalization makes competition ever greater in a wide variety of economic sectors because of the easier access to other markets beside the internal ones. It also tends to make investment opportunities more flexible due to a broader applicability of technology to other purposes besides the original ones.

Today, in many economic industries the focus of competition is set at a global scale. Globalization of the market economy makes competition transferable to a world level. However, the possibility to compete at a global scale is only accessible to a limited number of firms. Therefore, such general increase in competition also causes a difference in the type of competition global firms have to face. In fact, such competition is being performed by a limited number of firms in each particular industry. We are witnessing an increase in competition by global firms that compete among themselves in different markets and in different products. In this setting, models that take into account the impact of one firm's decisions in the other firm's behaviour are the ones that better adjust to this economic environment. Therefore, game theoretic models of competition gain a renewed relevance.

At present, managerial flexibility is getting more and more present in investment opportunities. In fact, an investment opportunity, directed to a particular market, can more easily be replicated and developed to a broader one. In addition, technological breakthroughs can more easily be transferred to other industries. With globalization, access to external markets and the expansion of the initial concept to other realities is more easily performed. These two combined aspects lead to an increase in operational flexibility and highlight its present relevance. Models that incorporate such managerial flexibility are models that are best suited for today's economical

International Journal of Latest Trends in Finance & Economic Sciences
IJLTFES, E-ISSN: 2047-0916

environment. Therefore, real options models gain a renewed relevance.

Additionally, at present times we are facing tremendous constraints in financial markets. The recent financial crisis affected immensely the way in which financial markets operate and their capability to provide the necessary funding to firms. This increased difficulty results mainly from a lack of liquidity in these markets. Among others, three consequences from this situation are worth being mentioned for the purpose of the present research. Firstly, the financing of investments is now a harder task than it was before. Secondly, the problems between the different stakeholders of the firm tend to be worse than before. Thirdly, it is much more difficult for firms to rollover their initial debt issues. Models that take into account these different, yet complementary, aspects reflect better the actual economic environment. However, we shall concentrate the analysis in the problems that arise between the different stakeholders of the firm. Therefore, agency theoretic models gain a renewed relevance.

Despite the fact that the above mentioned effects are not all reflected in all industries, they are widespread in different magnitudes to different industries. However, for some particular industries they are all present. In fact, global firms which operate in markets where entry barriers do exist face all the above mentioned effects. They face a fearsome competition but only from a limited number of rivals. They generally possess high operational flexibility since they can easily proceed to other markets, hence they are global. They also possess technology that can easily be adopted by other industries, thus enlarging such operational flexibility. And finally, they also face financial constraints because of the lack of liquidity present in financial markets, which causes agency conflicts between their stakeholders.

As a consequence of all these combined effects, a reflection about the new conditions that affect managerial decisions is necessary, namely, decisions concerning investment opportunities. With this new economic environment investment decisions are particularly affected. Higher economic uncertainty increases the risk associated with expected future cash-flows. Lack of liquidity in financial markets increases the cost of equity and debt financing.

The focus of the present research is the analysis of the impact of the financing structure in investment decisions that present managerial flexibility in a competitive market. However, such model must depart from previous work developed in the different fields of research that are being integrated.

Smit and Trigeorgis (2004) conclude that market structures portray an influence on the firm's investment decisions. In a static approach to competition, it was shown that different market equilibriums, namely Cournot-Nash and Stackelberg, result in differences in the investment decisions of firms, and therefore, in firm value. In a duopoly setting, with both firms sharing a growth option and possessing an abandonment option, alternative competitive responses are analyzed. Departing from the monopolistic market structure as benchmark, the analysis derives the expressions for firm value under Cournot-Nash and Stackelberg equilibriums. Therefore, it is examined how such equilibrium competitive responses influence investment decisions and firm value through the differences in firm value compared to the monopolistic market structure.

Mauer and Ott (2000) and Childs et al. (2005) demonstrate that the exercise of growth options can, under certain financial structures, lead to an underinvestment problem, due to the existence of agency conflicts between equityholders and debtholders of the firm. In a typical underinvestment situation, equityholders decide to invest later in a project (with similar risk characteristics to the existing portfolio of investment projects) when compared to the optimal investment timing because the increase in the asset base will increase the value of the debtholders' claims at the expense of equityholders. Rather than investing when it is optimal for the firm, equityholders tend to wait until the market evolves favorably and invest at a higher price of the underlying asset / project when the increase in value of the debtholders' claims is not accomplished at the expense of equityholders. Since the debtholders claim is fixed, they cannot expect to gain more than seeing their claim become riskless. This can occur either by a reduction on the volatility of the underlying asset or by an increase of the asset basis of the firm. If the increase is due to an additional investment performed by equityholders, the debtholders will benefit from it without having incurred in any additional cost. On the equityholders perspective, whatever return their additional investment yields, it is going to be shared with the debtholders. They support all the costs and have to share the benefits. If equityholders wait to invest at a higher value of the underlying asset (project's present value), debtholders will have already benefited from this increase and whatever return equityholders get from the investment decision, it will no longer be shared with debtholders. This explains why, in the presence of pure expansion options, equityholders have an incentive to underinvest.

Therefore, in the present research a discrete-time real options analysis will be implemented. The model must also take into account the existence of agency conflicts between equity and debt in a scenario where competition between two identical firms is present. Furthermore, it will be specified that both firms will act as Cournot competitors.

2. Research Background

In this section a brief review highlighting the fundamental research that relates managerial flexibility in the presence of agency conflicts between equity and debt and in the presence of competition will be specified.

2.1. Agency Conflicts under Real Options Analysis

In this section we will briefly review some of the most relevant articles that contribute to the study of the interactions referred to above. We will start with the reference to the main articles that refer to the interaction between investment and financing decisions until a central article that performs such analysis in a real options framework and conclude with the first introduction of competition in a context of managerial flexibility.

The celebrated paper from Modigliani and Miller (1958) stated explicitly the indifference between different financing alternatives and the irrelevance of financing decisions to the market value of the firm. Consequently, it implied that firm's investment decisions are independent of its financing policy. In fact, they demonstrated that given the firm's investment policy and ignoring taxes and contracting costs, the firm's choice of financing policy does not affect its current market value. Despite the huge breakthrough in financial theory that such recognition enabled, it left unanswered the observed practice of corporate financing policies. Later, introduction of corporate and personal taxes as well as assumption of bankruptcy costs led to the failure of the indifference proposition, so that the firm must choose an optimal financing method. However, under these developments, the independence proposition still holds.

Later, Jensen and Meckling (1976) studied the impact that an agency conflict among stockholders, managers and bondholders has on the investment and financing decisions of the firm. They argued that the capital structure problem involves the determination of the entire set of contracts among the different stakeholders of the firm. Afterwards, Myers [9] argued that, in the presence of debt financing, a conflict of interests between equityholders and debtholders emerges. With this recognition, the financing structure is no longer irrelevant to the investment decision of corporations.

Mauer and Ott (2000) studied the impact of managerial flexibility in the relationship between investment and financing decisions. In a real options and agency theoretic framework, they argued that levered equityholders of a firm with assets in place and owning a growth option to expand its scale of operations, have an underinvestment incentive whenever the growth option is solely equity financed. An underinvestment incentive is traditionally viewed as investing less than the optimal in order to avoid a wealth transfer from equityholders to debtholders. However, it can also be viewed as a delay in the optimal investment timing, which ultimately might lead to a reduction in investment.

2.2. Competition under Real Options Analysis

The initial model developed under this setting was Smit and Ankum (1993). Despite the intuitive presentation of fundamental aspects relating competition with investment possibilities the framework was not continued until Smit and Trigeorgis (2001). They analyzed in discrete-time the trade-offs between managerial flexibility and commitment in a dynamic competitive setting under uncertainty. In fact, they extended the framework developed in Smit and Ankum (1993) by explaining the source of firm heterogeneity and quantifying the trade-off between commitment and flexibility.

Smit and Trigeorgis (2001) considered a scenario where two firms compete in two different stages of product development. Under this scenario, the early exercise of strategic investments can change later stages for the better. In fact, it can open new market opportunities or enhance the value of their investment options. Therefore, a firm can make a first-stage strategic investment possibly altering the later equilibrium strategic choices. Firms are initially assumed equal in the second competition stage but one firm may introduce some asymmetry by making this first-stage investment. Hence, the initial investment decision requires the firm to weigh the commitment cost against the expected future strategic benefits of commitment. For the different possible investment orderings considered, simultaneous, sequential or singular, it is defined a set of corresponding market outcomes, Cournot, Stackelberg or monopoly. These market outcomes are used to calculate the final payoffs. Following Fudenberg and Tirole (1984), the strategic effect of the committing first-stage investment depends on the type of competitive reaction and the nature of the commitment. The firm's investment is either tough or soft. If firm (re)actions are strategic substitutes (as under Cournot quantity competition), the competing firm will engage less for an aggressive action by the rival firm. Conversely, firms' (re)actions can be strategic complements (as under differentiated Bertrand price competition). Smit and Trigeorgis (2001) construct and solve four numerical examples illustrating all possible combinations of competitive reaction and the investment type. Upfront investment is only optimal for the first firm to act in the two cases where the strategic effect is positive. For the cases with negative strategic effect, the first firm to act should not invest. It should benefit from increased uncertainty as its stage-two investment option becomes more valuable. But at the same time uncertainty erodes the value of committing as the upfront investment becomes riskier. Smit and Trigeorgis (2007, 2009) use this framework to assess R&D strategies and infrastructure investment decisions.

3. A Discrete-Time Agency Real Options Game Valuation Model

In the present section, a description of the discrete-time model developed is made. Next, a validation of such model, with the use of a simulation methodology is also made. The results achieved with such simulation are presented and analysed.

3.1. The Model

With two firms present in the market, we must start with the consideration that both firms face exogenous uncertainty in future market demand, which is in turn characterized by fluctuations in a demand parameter. It shall be assumed a linear inverse demand function of the form:

$$P(Q,\theta_t) = \theta_t - (Q_a + Q_b) \qquad (1)$$

Where θ_t is the demand shift parameter, assumed to follow a multiplicative binomial process, Qa and Qb are the quantities produced by both firms present in the market and P(Q) is the common market price as a function of total quantity (Qa + Qb). The demand shift parameter follows a binomial process and at the next time period it may increase by the multiplicative factor, u, or decrease by the multiplicative factor d[1].

With this evolution in time of the demand parameter, the value of the firm at the end node of the demand tree can easily be computed. The end node of the tree shall also be considered as the maturity date of the options and the maturity date of the debt outstanding. However, it is necessary to obtain the value of the firms without including the decisions to be taken by the firms considering the exercise of the options and the debt payment. In order to do so, we must derive firm value under the equilibrium alternative to be considered, Cournot-Nash.

The total variable production cost for a particular firm i (i = A or B) is given by:

$$C(Q_i) = c_i Q_i + \frac{1}{2} q_i Q_i^2 \qquad (2)$$

Here, ci and qi are the linear and quadratic cost coefficients. Therefore, the annual operating profit for each firm is given by:

$$\begin{aligned}\pi_i(Q_i, Q_j, \theta_t) &= PQ_i - C(Q_i) \\ &= [(\theta_t - c_i) - Q_j]Q_i \\ &\quad - \left(1 + \frac{1}{2} q_i\right) Q_i^2 \qquad (3)\end{aligned}$$

The value of the firm, assuming perpetual annual operating cash-flows thereafter, corporate tax τ, and a constant risk-adjusted discount rate κ, is given by:

$$V_i = \frac{\pi_i}{\kappa}(1-\tau) \qquad (4)$$

In order to obtain the reaction function of each firm under quantity competition it is necessary to maximize each firms profit function over its own given quantities. Each firm reaction function is thus:

$$R_i(Q_i) = \frac{\theta_t - c_i - Q_j}{2 + q_i} \qquad (5)$$

Since both firms equally share the market, they achieve Cournot-Nash equilibrium. The equilibrium quantities are obtained by equating both reaction functions. The end result is:

$$Q_i^* = \frac{(\theta_t - c_i)(2 + q_i) - (\theta_t - c_j)}{(2 + q_i)(2 + q_j) - 1} \qquad (6)$$

Simplifying the above expression, by setting $q_i = q_j = 0$, we obtain the following expression for the quantities:

$$Q_i^* = \frac{\theta_t - 2c_i - c_j}{3} \qquad (7)$$

[1] The multiplicative factors, u, d, are exogenous to the model but the relationship between them is in accordance to the standard relationship established in binomial processes. The probabilities associated with such movements are the actual probabilities. The multiplicative factor, u, has probability q, and the multiplicative factor d, has complementary probability (1-q).

These equilibrium quantities generate the following firm value:

$$V_i^* = \frac{(\theta_t - 2c_i + c_j)^2}{9\kappa}(1-\tau) \qquad (8)$$

Having derived firm value under Cournot-Nash equilibrium, it is now time to include managerial flexibility. That is represented by the possibility to expand the scale of operations, exercising the growth option, and by the possibility to abandon the market, exercising the abandonment option.

We shall start with the consideration of a growth option to expand its scale of operations. This type of option is typically assumed as an increment in firm value in exchange of the investment expenditure necessary to implement it. Therefore, it is like a call option on the increment in firm value with an exercise price equal to the investment expenditure necessary to implement it. The payoff at expiration date, for a call option with these characteristics can be represented by:

$$G = Max(gV - I, 0) \qquad (9)$$

In the expressions above, I represents the additional investment outlay necessary to expand the scale of operations, G represents option value and gV represents the increment in the value of the firm. With the terminal value for the call option on the cash flows of the project above derived, the value of such option at a particular time is obtained by the general binomial valuation model of a call option:

$$G_{t-1} = \frac{[puG_t + (1-p)dG_t]}{(1+r)} \qquad (10)$$

And with p, the risk neutral probability, being equal to:

$$p = \frac{\left[(1+r) - \left(\frac{\kappa}{1+\kappa}\right) - d\right]}{u-d} \qquad (11)$$

In the above expression, $\kappa/(1+\kappa)$ represents the constant asset (dividend like) payout yield for a perpetual project (or firm). If we extend this single period binomial model and subdivide the time to expiration of the growth option, T, into n equal subintervals, each of length $t = T/n$, the general binomial pricing formula can be represented as follows:

$$G = \frac{\sum_{j=0}^{n} \left\{\frac{n!}{j!(n-j!)}\right\} p^j (1-p)^{n-j} Max(u^j d^{n-j} gV - I, 0)}{(1+r)^n} \qquad (12)$$

This expression adds the probability that the firm will take j upward jumps in n steps, each with risk neutral probability p. These jumps are in accordance with the evolution of the demand parameter considered in the demand function.

It is now time to include the valuation methodology for the abandonment option. This type of option is typically assumed as a put option on the assets of the firm for the salvage value specified. The payoff at expiration date, for a put option with these characteristics can be represented by:

$$A = Max(X - V, 0) \qquad (13)$$

In the expressions above, X represent the salvage value at which the firm can be abandoned, A represents option value and V represents the value of the firm.

With the terminal value for the put option on firm value above derived, the value of such option at a particular time is obtained by the general binomial valuation model for a put option:

$$P_{t-1} = \frac{[puP_t + (1-p)dP_t]}{(1+r)} \qquad (14)$$

If we again extend this single period binomial model and subdivide the time to expiration of the growth option, T, into n equal subintervals, each of length $t = T/n$, the general binomial pricing formula can be represented as follows:

$$A = \frac{\sum_{j=0}^{n} \left\{ \frac{n!}{j!(n-j!)} \right\} p^{j} (1-p)^{n-j} Max\left(X - u^{j} d^{n-j} V, 0 \right)}{(1+r)^{n}} \quad (15)$$

This expression also adds the probability that the firm will take j upward jumps in n steps, each with risk neutral probability p. Once again, such probability is in accordance with the demand parameter considered initially.

With the two managerial possibilities present, it is now the time to develop the value of the firm after such flexibility is incorporated in the firm values derived. It results from the value of the firm obtained in accordance to the market equilibrium defined, without consideration of flexibility, with the addition of these two managerial possibilities the firm possesses. At the maturity date of the options, the value of the firm with the addition of the growth option is given by:

$$V^{G} = V + Max[(g-1)V - I, 0] \quad (16)$$

This is equal to:

$$V^{G} = Max[gV - I, V] \quad (17)$$

At the maturity date of the options, the value of the firm with the addition of the abandonment option is given by:

$$V^{A} = V + Max(X - V, 0) \quad (18)$$

This is equal to:

$$V^{A} = Max(X, V) \quad (19)$$

Therefore, the value of the firm results from the initial value of the firm and these two managerial possibilities the firm possesses. At the maturity date of the options, it is given by:

$$V^{GA} = Max(V, gV - I, X) \quad (20)$$

By substituting firm value as in the different market equilibriums considered, we obtain the value of the firm under Cournot-Nash as:

$$V^{C} = Max\left(\frac{(\theta_{t} - 2c_{i} + c_{j})^{2}}{9\kappa}(1-\tau), g\frac{(\theta_{t} - 2c_{i} + c_{j})^{2}}{9\kappa}(1-\tau) - I, X \right) \quad (21)$$

The value of the firm with the managerial flexibility present at a date prior to the expiration date of the options considered follows a similar path to the one described for the value of the options when considered in isolation. Therefore, it can be computed as follows:

$$V^{GA} = \frac{\sum_{j=0}^{n} \left\{ \frac{n!}{j!(n-j!)} \right\} p^{j} (1-p)^{n-j} Max\left(u^{j} d^{n-j} V, u^{j} d^{n-j} V + g u^{j} d^{n-j} V - I, A \right)}{(1+r)^{n}} \quad (22)$$

After this computation, it is necessary to incorporate the agency conflicts that result from the additional equity issue necessary in order to exercise the growth option. Under the consideration that the firm is financed by both equity and debt, the total current market value of the firm, V, is the sum of the market value of the two securities. Therefore,

$$V = E + D \quad (23)$$

Where E represents the market value of equity and D represents the market value of debt. Under this scenario, equity can be seen as a call option on the assets of the firm. The exercise value of such call option is the value of outstanding debt. The maturity of this option is the maturity of the debt. Under the present setting, such maturity date is the same as the maturity date of the options considered. Therefore, the general value for the equity of the firm at debt maturity can be represented as follows:

$$E_{T} = Max(V_{T} - F, 0) \quad (24)$$

In this expression, F represents the face value of debt outstanding while ET and VT represent the equity and firm value at the maturity date of debt. Being a call option on the assets of the firm, the value of equity at any date before the maturity date of the debt contract, can be estimated as:

$$E = \frac{\sum_{j=0}^{n} \left\{ \frac{n!}{j!(n-j!)} \right\} p^{j} (1-p)^{n-j} Max\left(u^{j} d^{n-j} V - F, 0\right)}{(1+r)^{n}} \quad (25)$$

Furthermore, the value of debt can be obtained by deducting to the value of the firm, the value of the equity. Alternatively, it can be computed as the difference between the value of the firm and the value of a call option on the assets of the firm with an exercise price equal to the face value of debt outstanding. Therefore, it can be given by:

$$D_T = V_T - Max(V_T - F, 0) \quad (26)$$

The end result of this perspective is:

$$D_T = \min(V_T, F) \quad (27)$$

The present value of this terminal value is obtained by the following expression:

$$D = \frac{\sum_{j=0}^{n} \left\{ \frac{n!}{j!(n-j!)} \right\} p^{j} (1-p)^{n-j} \min\left(u^{j} d^{n-j} V, F\right)}{(1+r)^{n}} \quad (28)$$

This is the general model that will be used to obtain the market value of the firm as well as the market value of equity and debt. However, with the inclusion of managerial flexibility and consideration of debt financing, we get additional results for equity and debt value under the different market equilibriums considered.

In the presence of Cournot-Nash equilibrium without managerial flexibility, and applying Eq. (8) into Eq. (24), we get the expression for equity value as:

$$E^{C} = Max\left(\frac{(\theta_t - 2c_i + c_j)^2}{9\kappa} (1-\tau) - F, 0 \right) \quad (29)$$

And applying Eq. (8) into Eq. (27), we get the expression for debt value as:

$$D^{C} = \min\left(\frac{(\theta_t - 2c_i + c_j)^2}{9\kappa} (1-\tau), F \right) \quad (30)$$

When in the presence of managerial flexibility, the expressions for the value of the equity and for the value of the debt can be obtained by substituting Eq. (21) into Eq. (24) and Eq. (27):

$$E^{C} = Max\left[Max\left(\frac{(\theta_t - 2c_i + c_j)^2}{9\kappa} (1-\tau), g \frac{(\theta_t - 2c_i + c_j)^2}{9\kappa} (1-\tau) - I, X \right) - F, 0 \right] \quad (31)$$

$$D^{C} = \min\left[Max\left(\frac{(\theta_t - 2c_i + c_j)^2}{9\kappa} (1-\tau), g \frac{(\theta_t - 2c_i + c_j)^2}{9\kappa} (1-\tau) - I, X \right), F \right] \quad (32)$$

This set of expressions defines the model implemented in the present research. Additionally, the insight that determines the agency cost of debt is that two different policies shall be considered in order to exercise the growth option. The first-best policy considers that such option will be exercised in order to maximize the value of the firm. The second-best policy considers that such option will be exercised in order to maximize the value of the equity of the firm.

The difference in firm value that results from these two different policies is the agency cost of debt.

For the first-best policy, the expressions are already derived, since they correspond to the maximization of firm value. Therefore, they are in accordance with the expressions derived for firm value. However, for the second-best policy, it must be noted that the expressions that were derived for the value of the equity of the firm do not correspond to the decision to be taken by firms that execute the second-best policy. The expression derived for the equity value corresponds to the value of equity that results from the maximization of firm value. It is not the maximization of equity value. Therefore, an expression for the maximization of equity value must be derived. The exercise of the option maximizes the equity value if firm value after exercise minus the value of debt outstanding and the value of the additional equity issue is higher than the value of the firm without exercise of the option minus the value of the debt outstanding. Under this premise, equity guarantees that the additional equity issue is not appropriated by the original debt. Therefore, the wealth transfer does not occur. Therefore, firm value under the second best policy can be derived from:

$$V_T = \begin{cases} gV - I & , gV - 2I - F \geq V - F \\ V & , gV - 2I - F < V - F \end{cases} \qquad (33)$$

With this policy, derivation of firm value in the different market equilibriums reached is obtained by the straightforward procedure of substituting the expressions for firm value in Eq. (33). The equity and debt values are also obtained by the incorporation of the firm value obtained in the expressions previously derived for the equity and debt value. With the model fully described it is now the time to implement it. In the next section we shall perform a numerical simulation of the model constructed in order to analyse the results achieved with it.

3.2. Results

The implementation shall be made with a numerical analysis performed through a simulation of a set of parameters. We shall start by the definition of all the necessary parameters to perform such simulation, after that we shall proceed to the numerical analysis ending with the main conclusions to be withdrawn from the analysis made.

3.2.1 Parameters

The numerical analysis to be performed assumes a duopolistic market where both firms share a growth option to expand the scale of operations and an abandonment option. Both firms have equal operating costs and it is further assumed, initially, that both firms will have identical financing structures and both firms will finance the growth option in equal form (through an additional equity issue). The necessary parameters in order to implement the model are the following:

Table 1. Parameters

Parameter	Value	Parameter	Value
θ0	17.50	Ca	5.00
u	1.25	Cb	5.00
d	0.80	F	50.00
rf	2.000%	X	0.00
κ	8.000%	g	3.00
τ	25.000%	I	50.00

This set of values is an adaptation of the set of values that were present in Smit and Trigeorgis (2004). Furthermore, some additional values were adjusted to the present market and legal conditions. With this set of values, we shall proceed to the valuation of the firm.

3.2.2 Results

Under the scenario without flexibility we get the following values for the value of the firm, its equity and its debt:

Table 2. Results

Parameter	Value	Parameter	Value
Va	118.49	Vb	118.49
Ea	84.67	Eb	84.67
Da	33.82	Db	33.82

With the inclusion of flexibility under the first-best policy, the values for the firm, its equity and its debt are naturally higher due to the existence, and exercise of the operational flexibility. They are presented below:

Table 3. Results

Parameter	**Value**	**Parameter**	**Value**
Va	317.03	Vb	317.03
Ea	279.52	Eb	279.52
Da	37.51	Db	37.51

It must be referred that with the adoption of the growth option, the value of the debt increases significantly, 10.89%. The wealth transfer effect mentioned in the literature is also present in this formulation. The growth option is financed by an additional equity issue, but part of the benefits from such additional equity issue is transferred to the debtholders of the firm.

In order to prevent such transfer of value, management adopts a second-best strategy. Under this strategy, the adoption of the growth option is determined by the maximization of the equity value of the firm and not by the maximization of firm value. The results achieved under this strategy are presented below:

Table 4. Results

Parameter	**Value**	**Parameter**	**Value**
Va	305.91	Vb	305.91
Ea	272.08	Eb	272.08
Da	33.82	Db	33.82
Ea (additional)	18.49	Eb (additional)	18.49

It is clear from the above table that the value of the firms diminishes compared to the first-best policy firm value. The decrease in value is of 3.51% when compared to firm value with the adoption of the first-best policy. This decrease represents the agency cost of debt as a result of an underinvestment in the growth option, consequence of the change in the strategy adopted to exercise it. The value of the debt decreases to the initial debt value (in the scenario without flexibility), becoming this way clear that debt is not benefited from the additional equity issue. The value of the equity also diminishes, when compared to the one obtained under the first-best policy. However, the "savings" in the additional equity issue possess a present value of 18.49. This reduction in the equity issue necessary to exercise the growth option is an increase in the value to the equity (in a global perspective, including the initial equity and the additional equity issue) that largely compensates the loss originated from the reduction in the exercise of the growth option under the second best policy. The computation of this additional value is necessary in order to establish the difference between the two policies considered. In fact, by adopting the second-best policy, the firms exercise the growth option in a reduced number of branches of the demand tree. Therefore, the comparison between firm values in the two policies considered needs to include the additional investment in which the firms incur by adopting the first-best policy in comparison to the adoption of the alternative policy.

The results obtained under Cournot-Nash clearly show that under the premises assumed, the agency cost exists and is significant. It leads to a reduction in the value of the firm as a consequence of the underinvestment situation caused by the adoption of a second-best policy. These results, under this equilibrium perspective are identical to both firms, since they equally share the market.

4. Conclusions

The economic environment that firms face is in constant transformation. At the present, such economic environment is characterized by higher operational (managerial) flexibility, competition and lack of liquidity in financial markets. This is the result of an increased globalization of the economy and of the crisis that affected financial markets. These events affect managerial decisions, particularly the ones related to capital budgeting. Therefore, a research conducted for the analysis of capital budgeting decisions under these new economic setting is extremely relevant in order to develop the current literature on the subject and to improve professional practice. This is the first conclusion to be withdrawn from the present dissertation. With the integration of three different theories into a unified perspective we aimed at an enhancement in the knowledge related to capital budgeting under competition and managerial flexibility, in the presence of agency conflicts between equity and debt. Such enhancement contributes to improved managerial decisions and therefore to added value in corporations.

In order to achieve it, we departed from a general approach to the problem through an analysis conducted on the fundamental literature on the subjects. The model developed was presented, describing the assumptions under which it was constructed. Later still, a numerical solution was implemented through a simulation set that enabled the extraction of results for analysis.

In order to clarify the main results achieved, these are separated between reflections about the model itself and considerations about the outcomes of the numerical simulation implemented. Finally, remarks regarding future possibilities of research will be presented.

The model developed departed from two previous works, one that integrated agency conflicts with ROA (Mauer and Ott, 2000), and another one that integrated ROA and competition (Smit and Trigeorgis, 2004). The first was in continuous-time and the second in discrete-time. Despite the widespread use of continuous-time models, we adopted the discrete-time perspective. This decision was based in the higher practical application of this type of models. In fact, the literature refers that one factor that might pose a barrier to the widespread use of real options models in corporation is the complexity continuous-time models possess. Therefore, the adoption of a discrete-time model can overcome such difficulty. On the other hand, models that analyse the interaction between investment and financing decisions tend to consider debt as "perpetual", in the sense that the rollover of the initial debt issue is considered feasible, and continuous-time models are best suited for such assumption. The model developed in the present dissertation does not consider so. In fact, due to the current situation of financial markets we opted to assume that the initial debt issue must be repaid at its maturity date. This assumption reinforced the possibility to develop a discrete-time model, since under these models it is necessary to establish a maturity for the options present. Therefore, the analysis developed gains in tractably, is best suited for adoption in real life practice and is more in accordance to actual conditions in financial markets.

The equilibrium conditions largely rely on the model developed by Smit and Trigeorgis (2004). The equilibrium defined is in line with Cournot Equilibrium and is, therefore, well established in the literature. The simulation performed intended to define a set of conditions that enables the achievement of results from implementation of the model. That simulation allowed us to understand better the managerial decisions taken under the set of conditions defined. In fact, concerning a competitive market with a shared growth option in which firms face agency conflicts between equity and debt, the model attempted to illustrate the decisions that firms should take. The results, for the numerical simulations developed, are conclusive.

It became clear that under Cournot-Nash equilibrium an incentive to underinvest exists whenever the firm is financed by both equity and debt, and the growth option is financed solely by equity. A wealth transfer occurs between equity and debt. The solution to avoid such wealth transfer is to delay investment in the growth option, which generates a reduction in firm value. This reduction in firm value is the agency cost of debt.

The path followed opens a different perspective of research in this field. In fact, the model constructed can easily be reformulated to incorporate other possibilities besides the ones considered. Namely, the possibility of consideration of other forms of financing is open wide. In fact, consideration of alternative financing structures for the firms or for the exercise of the growth option is a logical and natural step. We replicated the financing conditions present in Mauer and Ott (2000). A replication of the financing conditions present in Mauer and Sarkar (2005) is a useful step that will generate relevant conclusions for this field of research. It can also be analysed the use of instruments of debt that could mitigate the agency conflicts present, namely callable or convertible debt instruments.

Alternatively, other forms of equilibrium could also be analysed. In fact, the adoption of the Cournot equilibrium conditions was justified with the adoption of the assumptions present in Smit and Trigeorgis (2004). Nonetheless, other possibilities do exist that could be studied. A Bertrand price competition is a logical development, as well as Stackelberg equilibrium also in line with the developments in Smit and Trigeorgis (2004).

Empirical testing of the present findings is another path that can be followed for the future. In fact, the testing of the present model could be made by its verification on oligopolistic sectors where innovation is present. Under ROA, empirical analysis is not yet very widespread. However, the validation of theoretical findings has a lot to gain with its empirical confirmation. The theoretical findings reached in this research are no exception.

The present research allowed the determination of the equilibrium conditions that might be present in competitive markets with shared growth options and abandonment options under agency conflicts between equity and debt. The comprehension of the factors that affect managerial decisions under these conditions is far from being reached, even because other aspects besides the ones here analysed interfere with those decisions. However, the breakthrough achieved in this research is one more step in the knowledge of those decisions.

Acknowledgements

This work was financially supported by FCT through the Strategic Project PEst-OE/EGE/UI0315/2011.

References

[1] Barclay, M., Morellec, E., & Smith, C. (2006), On the Debt Capacity of Growth Options, *The Journal of Business*, No. 79, pp. 37-60.

[2] Barclay, M., Smith, C., & Watts, R. (1995), The Determinants of Corporate Leverage and Dividend Policies, *Journal of Applied Corporate Finance*, No. 7, pp. 4-19.

[3] Black, F., & Scholes, M. (1973), The Pricing of Options and Corporate Liabilities, *Journal of Political Economy*, No. 81, pp. 637-659.

[4] Bouis, R., Huisman, K. & Kort, P. (2009), Investment in Oligopoly under Uncertainty: The Accordion Effect, *International Journal of Industrial Organization*, No. 27, pp. 320-331.

[5] Boyer, M., Gravel, E., & Lasserre, P. (2004a), Real Options and Strategic Competition: A Survey, Working Paper, Economics and CIRANO, University de Montreal.

[6] Brennan, M. J., & Schwartz, E. S. (1985), Evaluating Natural Resources Investments, *Journal of Business*, No. 58, pp. 135-157.

[7] Brennan, M. J., Trigeorgis, L. (Eds.) (2000), *Project Flexibility, Agency, and Competition: New Developments in the Theory and Application of Real Options*, New York, NY: Oxford University Press.

[8] Chevalier-Roignant, B., Flath, C., Huchzermeier, A, & Trigeorgis, L. (2011), Strategic Investment under Uncertainty: A Synthesis, *European Journal of Operational Research*, No. 215, pp. 639-650.

[9] Chevalier-Roignant, B., & Trigeorgis, L. (2011), *Competitive Strategy: Options and Games*, Cambridge, MA: The MIT Press.

[10] Childs, P., Mauer, D., & Ott, S. (2005), Interactions of Corporate Financing and Investment Decisions: The Effect of Growth Options to Replace or Expand, *Journal of Financial Economics*, No. 76, pp. 667-690.

[11] Copeland, T., & Antikarov, V. (2001), *Real Options: A Practitioner's Guide*, New York, NY: Texere Publishing.

[12] Cox, J. C., Ross, S. A., & Rubinstein, M. (1979), Option Pricing: A Simplified Approach, *Journal of Financial Economics*, No. 7, pp. 229-263.

[13] Dixit, A., & Pindyck, R. (1994), *Investment under Uncertainty*, Princeton, NY: Princeton University Press.

[14] Filipe, J. (2006), *O Drama dos Recursos Comuns: Um Caso de Aplicação da Teoria dos Jogos aos Comuns da Pesca*, PhD Thesis, Departamento de Métodos Quantitativos, ISCTE.

[15] Filipe, J. & Monteiro, J. (2008), Agency Conflicts and Competitive Interaction under Managerial Flexibility in Investment Decisions, *Proceedings of the 7th International Conference on Applied Mathematics (APLIMAT)*, Bratislava: Slovak Republic, Slovak University of Technology in Bratislava, pp. 455-462.

[16] Filipe, J. & Monteiro, J. (2011), A Framework for the Analysis of the Impact of Competition on Investment Decisions in the Presence of Managerial and Financial Flexibility, *Portuguese Journal of Quantitative Methods*, No. 1, pp. 75-84.

[17] Fudenberg, D. & Tirole, J. (1984), The Fat-cat Effect, the Puppy-dog Ploy, and the Lean and Hungry Look, American Economic Review, No. 74, pp. 361-366.

[18] Fudenberg, D., & Tirole, J. (1991), *Game Theory*, Cambridge, MA: The MIT Press.

[19] Grenadier, S. (2002), Option Exercise Games: An Application to the Equilibrium Investment Strategies of Firms, *Review of Financial Studies*, No. 15, pp. 691- 721.

[20] Huisman, K., & Kort, P. (2009), Strategic Capacity Investment under Uncertainty, *Presented at the 13th Annual International Conference on Real Options*, Braga: Portugal, Universidade do Minho.

[21] Jensen, M. (1986), Agency Costs of Free Cash Flow, Corporate Finance and Takeovers, *American Economic Review*, No. 76, pp. 323-329.

[22] Jensen, M., & Meckling, W. (1976), Theory of the Firm: Managerial Behaviour, Agency Costs, and Ownership Structure, *Journal of Financial Economics*, No. 3, pp. 305-360.

[23] Jensen, M. & Smith, C. (1985), Stockholder, Manager and Creditor Interests: Applications of Agency Theory, in E. Altman and M. Subrahmanyam (Eds.), *Recent Advances in Corporate Finance*, Homewood, Ill.: Irwin, pp. 93-131.

[24] Jou, J-B., & Lee, T. (2004), The Agency Problem, Investment Decision and Optimal Financial Structure, *The European Journal of Finance*, No. 10, pp. 489-509.

[25] Mauer, D., & Ott, S. (1995), Investment under Uncertainty: the Case of Replacement Investment Decisions, *Journal of Financial and Quantitative Analysis*, No. 30, pp. 581-605.

[26] Mauer, D., & Ott, S. (2000), Agency Costs, Underinvestment, and Optimal Capital Structure, in M. J. Brennan and L. Trigeorgis (Eds.), *Project Flexibility, Agency, and Competition: New Developments in the Theory and Application of Real Options*, New York, NY: Oxford University Press, pp. 151-179.

[27] Mauer, D., & Sarkar, S. (2005), Real Options, Agency Conflicts, and Financial Policy, *Journal of Banking and Finance*, No. 29, pp. 1405-1428.

[28] Mauer, D., & Triantis, A. J. (1994), Interaction of Corporate Financing and Investment Decisions: a Dynamic Framework, *The Journal of Finance*, No. 49, pp. 1253-1277.

[29] Merton, R. (1973), Theory of Rational Options Pricing, *Bell Journal of Economics*, No. 4, pp. 141-183.

[30] Modigliani, F., & Miller, M. (1958), The Cost of Capital, Corporation Finance and the Theory of Investment, American Economic Review, No. 48, pp. 261-297.

[31] Modigliani, F., & Miller, M. (1963), Corporate Income Taxes and the Cost of Capital: A Correction, American Economic Review, No. 53, pp. 433-443.

[32] Monteiro, J. (2004), *Re-evaluation of Mauer and Ott Agency-Real-Options Framework in a Complex Hybrid Structure Context*, MSc Thesis, UCP.

[33] Morellec, E., & Smith, C. (2007), Agency Conflicts and Risk Management, Review of Finance, 11, 1-23.

[34] Smit, H., & Ankum, L. (1993), A Real Options and Game-Theoretic Approach to Corporate Investment under Competition, *Financial Management*, No. 22, pp. 241-250.

[35] Smit, H., & Trigeorgis, L. (2001), Flexibility and Commitment in Strategic Investment, in E. Schwartz & L. Trigeorgis (Eds.), *Real Options and Investment under Uncertainty, Classical Readings and Recent Contributions*, Cambridge, MA: MIT Press, pp. 451-498.

[36] Smit, H., & Trigeorgis, L. (2004), *Strategic Investment: Real Options and Games*, Princeton, NJ: Princeton University Press.

[37] Smit, H., & Trigeorgis, L. (2006), Real Options and Games: Competition, Alliances and other Applications of Valuation and Strategy, *Review of Financial Economics*, No. 15, pp. 95-112.

[38] Smit, H., & Trigeorgis, L. (2007), Strategic Options and Games in Analysing Dynamic Technology Investments, *Long Range Planning*, No. 40, pp. 84-114.

[39] Smit, H., & Trigeorgis, L. (2009), Valuing Infrastructure Investment: an Option Games Approach, California Management Review, No. 51, pp. 79-90.

[40] Titman, S., & Tsyplakov, S. (2002), A Dynamic Model of Optimal Capital Structure, Working Paper, University of Texas.

[41] Titman, S., Tompaidis, S., & Tsyplakov, S. (2004), Market Imperfections, Investment Flexibility, and Default Spreads, *The Journal of Finance*, No. 59, pp. 165-205.

[42] Trigeorgis, L. (1993), Real Options and Interactions with Financial Flexibility, *Financial Management*, No. 22, pp. 202-224.